

CLAIMS:

- 1 1. A method of diagnosing pathologic heart conditions comprising:
2 identifying a systolic sub-interval of a systolic interval for a plurality of heart
3 cycles in a sequence of heart cycles;
4 computing an energy value for each systolic sub-interval;
5 computing a composite energy value using the computed energy values for each
6 systolic sub-interval; and
7 comparing the composite energy value to a threshold level in order to distinguish
8 between a normal heart and a pathologic heart.
- 1 2. A method of diagnosing pathologic heart conditions comprising:
2 filtering a time series of heart sounds;
3 parsing the time series of heart sounds into a sequence of individual heart cycles;
4 identifying a systolic interval for each heart cycle;
5 identifying a systolic sub-interval of the systolic interval for each heart cycle;
6 computing an energy value for the systolic sub-interval of one or more heart
7 cycles, said energy value being proportional to the energy level associated with the filtered
8 series of heart sounds;
9 computing a composite energy value for the systolic sub-intervals of one or more
10 heart cycles; and
11 comparing the composite energy value to a threshold level in order to distinguish
12 between a normal heart and a pathologic heart.
- 1 3. The method of claim 2 wherein said parsing step uses electro-cardiogram (ECG)
2 data in order to transform a time series of heart sounds into a sequence of individual heart
3 cycles.
- 1 4. The method of claim 2 wherein said parsing step uses acoustic heart sounds
2 obtained directly from a patient in order to transform a time series of heart sounds into a
3 sequence of individual heart cycles.

1 5. The method of claim 2 wherein identifying a systolic interval for each heart cycle
2 is achieved by identifying pulses on an electro-cardiogram (ECG).

1 6. The method of claim 2 wherein identifying a systolic interval for each heart cycle
2 is achieved by acoustically locating a first and a second heart sound using a bandpass
3 filter, said bandpass filter applied to the time series of heart sounds.

1 7. The method of claim 2 wherein filtering the time series of heart sounds is achieved
2 using a bandpass filter.

1 8. The method of claim 2 wherein filtering the time series of heart sounds is achieved
2 using time-frequency transforms.

1 9. The method of claim 8 wherein the time-frequency transform is a wavelet
2 transform.

1 10. The method of claim 8 wherein the time-frequency transform is a Fourier
2 transform.

1 11. The method of claim 2 wherein the systolic sub-interval is centered in systole.

1 12. The method of claim 2 wherein the systolic sub-interval is centered in systole and
2 is half of the systolic interval.

1 13. The method of claim 2 wherein the composite energy value is computed as the
2 median of the computed energy values for more than one of the systolic sub-intervals of
3 the heart cycles.

1 14. The method of claim 2 wherein the composite energy value is computed as the
2 weighted average of more than one of the computed energy values for the systolic sub-
3 intervals of the heart cycles.

1 15. The method of claim 2 wherein the composite energy value is computed as the
2 median across more than one of the heart cycle systolic sub-intervals of a quantity
3 proportional to energy.

1 16. The method of claim 2 wherein the composite energy value is computed as the
2 weighted average energy value across more than one of the heart cycle systolic sub-
3 intervals.

1 17. The method of claim 14 wherein the ratio of energies between systolic interval and
2 diastolic interval are also used to distinguish a normal heart from a pathologic heart by
3 prior statistical characterization of the ratio of energies between systolic interval and
4 diastolic interval for normal and pathologic hearts.

1 18. The method of claim 14 wherein the standard deviation of the energy in a systolic
2 interval is also used to distinguish a normal heart from a pathologic heart by prior
3 statistical characterization of the standard deviation of the energy in a systolic interval for
4 normal and pathologic hearts.

1 19. A system for diagnosing pathologic heart conditions comprising:
2 a portable computing device for:
3 managing data collection from new patients;
4 storing data; and
5 analyzing data,
6 and
7 a patient data collection unit for acquiring electro-cardiogram (ECG) and heart
8 sound data from a patient, said patient data collection unit operatively connected with said
9 portable computing device.

1 20. The system of claim 17 wherein the patient data collection unit comprises:
2 a contact microphone for obtaining acoustic data;

3 an acoustic pre-amplifier operatively connected with said contact microphone, said
4 pre-amplifier having a passband of 20 Hz to 2 kHz used to condition acoustic data
5 received from said contact microphone;

6 a variable amplifier operatively connected with said acoustic pre-amplifier for
7 variably amplifying the conditioned acoustic data;

8 an electro-cardiogram (ECG) electrode;

9 an ECG amplifier operatively connected with said electro-cardiogram (ECG)
10 electrode;

11 an analog to digital converter operatively connected with said variable amplifier
12 and said ECG amplifier, said analog to digital converter for digitizing acoustic data and
13 electro-cardiogram (ECG) data.

1 21. A method of optimizing a heart auscultation screening algorithm comprising:
2 applying a heart auscultation screening time-frequency transform algorithm to a set
3 of data, wherein:

4 said algorithm includes wavelets and bandpass filters;

5 said data includes heart sounds known to be normal and heart sounds known to
6 be pathologic;

7 said heart sounds being characterized by a systolic interval;

8 said systolic interval capable of being divided into systolic sub-intervals,

9 recording the results of said heart auscultation screening algorithm for a variety of
10 time-frequency transform parameters and systolic sub-intervals; and

11 determining an optimal combination of wavelet scale parameter and systolic sub-
12 interval for use with said heart auscultation screening wavelet algorithm based on
13 sensitivity and specificity measurements.

1 22. A computer readable medium whose contents cause a computer based system to
2 determine patient heart pathology by:

3 identifying a systolic sub-interval of a systolic interval for a plurality of heart
4 cycles in a sequence of heart cycles;

5 computing an energy value for each systolic sub-interval;

6 computing a composite energy value using the computed energy values for each
7 systolic sub-interval; and

8 comparing the composite energy value to a threshold level in order to distinguish
9 between a normal heart and a pathologic heart.

1 23. A computer readable medium whose contents cause a computer based system to
2 determine patient heart pathology by:

3 filtering a time series of heart sounds;

4 parsing the time series of heart sounds into a sequence of individual heart cycles;

5 identifying a systolic interval for each heart cycle;

6 identifying a systolic sub-interval of the systolic interval for each heart cycle;

7 computing an energy value for the systolic sub-interval of one or more heart
8 cycles, said energy value being proportional to the energy level associated with the filtered
9 series of heart sounds;

10 computing a composite energy value for the systolic sub-intervals of one or more
11 heart cycles; and

12 comparing the composite energy value to a threshold level in order to distinguish
13 between a normal heart and a pathologic heart.

1 24. A computer readable medium whose contents transform a computer based system
2 into a heart pathology detection system, comprising:

3 a patient data collection subsystem for acquiring electro-cardiogram (ECG) and
4 heart sound data from a patient;

5 a data management subsystem for managing electro-cardiogram (ECG) and heart
6 sound data;

7 a data analysis subsystem for processing and analyzing electro-cardiogram (ECG)
8 and heart sound data; and

9 a data storage subsystem for storing processed electro-cardiogram (ECG) and heart
10 sound data.